Chemosphere 118 (2015) 1–4

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Levels of PCDDs, PCDFs and dl-PCBs in the blood of childbearing-aged women living in the vicinity of a chemical plant in Tianjin: A primary study

Chen Xi [a], Chen Jing-shan [a], Zhang Lei [b], Li Jing-guang [b], Yao Lena [c], Steven G. Self [c], Sun Xin [d,*], Tang Nai-jun [a,*]

[a] Dept. of Occupational and Environmental Health, School of Public Health, Tianjin Medical University, 22 Qi Xiang Tai Road, Heping District, Tianjin 300070, China
[b] Key Lab for Food Safety and Risk Assessment, Ministry of Public Health & China Center for Food Safety Risk Assessment, 7 Panjiayuan Nan Li, Chao Yang District, Beijing 100021, China
[c] Vaccine & Infectious Disease Division, Fred Hutchinson Cancer Research Center, 1100 Fairview Avenue North, Seattle, WA 98109, USA
[d] Key Lab of Chemical Safety and Health, Chinese Center for Disease Control and Prevention & National Institute of Occupational Health and Poison Control, Chinese Center for Disease Control and Prevention, 27 Nan Wei Road, West City District, Beijing 100050, China

HIGHLIGHTS

- Dioxins and dl-PCBs in serum from Chinese women in childbearing age.
- High levels up to 155 pg WHO 2005 TEQ g^{-1} lipid have been found.
- Levels increase with decreasing distance from a chemical plant.
- This pilot study provides basic information for future epidemiological studies.

ARTICLE INFO

Article history:
Received 12 August 2013
Received in revised form 11 May 2014
Accepted 13 May 2014

Handling Editor: J. de Boer

Keywords:
Dioxins
PCDDs
PCDFs
dl-PCBs
Childbearing-aged Women
Chemical Plant

ABSTRACT

Several studies have suggested that maternal exposure to Polychlorinated dibenzo-p-dioxins (PCDDs), poly-chlorinated dibenzofurans (PCDFs) and dioxin-like polychlorinated biphenyls (PCBs) may affect foetal growth and infant development. The aim of our study was to determine whether the childbearing-aged residents living near a chemical plant have a greater exposure risk. Concentrations of 17 PCDD/Fs congeners and 12 non-ortho and mono-ortho dioxin-like PCBs were measured using HRGC-HRMS in the blood of 30 non-occupational childbearing-aged women living near a chemical plant (Dagu) that had been producing chlorinated pesticides from 1958 to 2004. The factors that influenced the body burden were investigated based on responses to a questionnaire. Levels of PCDD/Fs + PCBs were in the range of 16.43–155.29 pg WHO 2005-TEQ g^{-1} lipid. PCDDs and PCDFs contributed 56.72% and 34.44%, respectively, to the total TEQ value. Total WHO-TEQ was approximately tenfold higher in the participants living in the vicinity of the plant (distance: 1.52 ± 0.148 km) than in the groups living farther away (distance: 4.93 ± 1.124 km). A negative correlation between total WHO-TEQ and distance to Dagu was observed by multiple linear regression models. The data provide basic information for monitoring dioxin-like chemicals in the district and for the future study of the relationship between POPs and pregnancy outcomes.

1. Introduction

Polychlorinated dibenzo-p-dioxins (PCDDs), poly-chlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) are major classes of POPs to which humans are exposed and which are shown to exert carcinogenicity, endocrinopathy, neurotoxicity and immunotoxicity. Tianjin once was a major organochlorine pesticide (OCP) production area in China, with most industries related to chemical pesticides being concentrated in the Tanggu District (Wang et al., 2007a, b; Hou et al., 2013). From 1958 to 2004 pentachlorophenol and its sodium salt were manufactured in the Tianjin Dagu Chemical Company (Dagu). Significant exposure of Dagu

* Corresponding authors. Tel.: +86 10 63185363; fax: +86 10 83132573 (X. Sun). Tel.: +86 22 83336630; fax: +86 22 83336608 (N.-J. Tang).
E-mail addresses: sunxin@chinacdc.cn (X. Sun), tangnaijun@tijmu.edu.cn (N.-j. Tang).

http://dx.doi.org/10.1016/j.chemosphere.2014.05.026
0045-6535/

employees has previously been demonstrated by very high blood levels of PCDDs/PCDFs (Coenraads et al., 1999). The factory operates in close proximity to a large number of villages, but exposure to PCDDs and PCDFs in the surrounding population has not been previously characterised. It was hypothesised that the residents living in the vicinity of the plant might be at an increased risk of exposure.

We conducted a small pilot study to explore the general levels of POPs in the blood of healthy women at child-bearing age (20–30 years old) who resided within 10 km of Dagu chemical factory. The 17 PCDDs/PCDFs and 12 dioxin-like PCBs (dl-PCBs) assigned a toxic equivalency factor (Van den Berg et al., 2006) that were selected based on environmental pollution and exposure data collected in Tianjin and other areas of China. This study represents the first measurement of blood levels of PCDDs/PCDFs and dl-PCBs in a population residing in the vicinity of Dagu.

2. Materials and methods

2.1. Sampling

Plasma samples from 30 individuals were obtained using standard phlebotomy methods in March 2013. The residence locations of all participants are shown in Fig. 1. None of these individuals had any known past or present occupational exposure to PCDD/PCDFs/dl-PCBs. The survey protocol was approved by the Ethics Committee of Tianjin Medical University (Tianjin, China). Written informed consent was obtained from the subjects at the time of the first examination.

Because the residents were unwilling to donate more than approximately 5 mL of blood, samples in which low amounts of PCDDs and PCDFs could be expected were pooled. Pooling was performed in six pools (termed A–F) of 5 samples each according to the distance of the residence to Dagu, where A is closest and F is farthest away. Samples were transported to the laboratory on ice within one hour of blood collection. After coagulation, samples were centrifuged to separate the serum, which was later transferred to clean glass containers and stored at −20 °C until analysis.

2.2. Analytical methods and instrumentation

Analysis of PCDD/Fs and dl-PCBs was performed according to EPA method 1613, with some modification. Briefly, approximately 30 g of pooled blood sample was freeze-dried before being blended with free crystalline silicic acid (EXtrelutNT, Merck KGaA, Germany). After spiking with $^{13}C_{12}$-labeled internal standards, samples were extracted with a mixture of n-hexane and dichloromethane (1:1, v/v) using Accelerated Solvent Extractor (ASE300, Dionex, USA) at 150 °C and 1500 psi. The bulk lipid was removed by shaking with acid-modified silica-gel after solvent evaporation, and further cleanup was achieved using a Power Prep instrument (Fluid Management Systems, Waltham, MA, USA) with multiple commercial silica-gel columns, alumina columns and carbon columns. Two fractions containing PCDD/Fs and dl-PCBs were selected and concentrated to approximately 20 μL, respectively. Prior to instrumental analysis, the $^{13}C_{12}$-labeled injection standard for PCDD/Fs and dl-PCBs was added to the final extracts, respectively.

The analysis of 17 toxic congeners of 2,3,7,8-substituted PCDD/Fs and 12 congeners of dl-PCBs designated by WHO was performed by a high resolution gas chromatograph – high resolution mass spectrometer (HRGC-HRMS, MAT95XP, ThermoFinnigan, Germany) with DB-5 MS capillary column (60 m × 0.25 mm i.d. × 0.25 μm) using an isotopic dilution method for quantification.

2.3. Questionnaire

A questionnaire was administered to each subject through an interview by a well-trained researcher. The questionnaire included

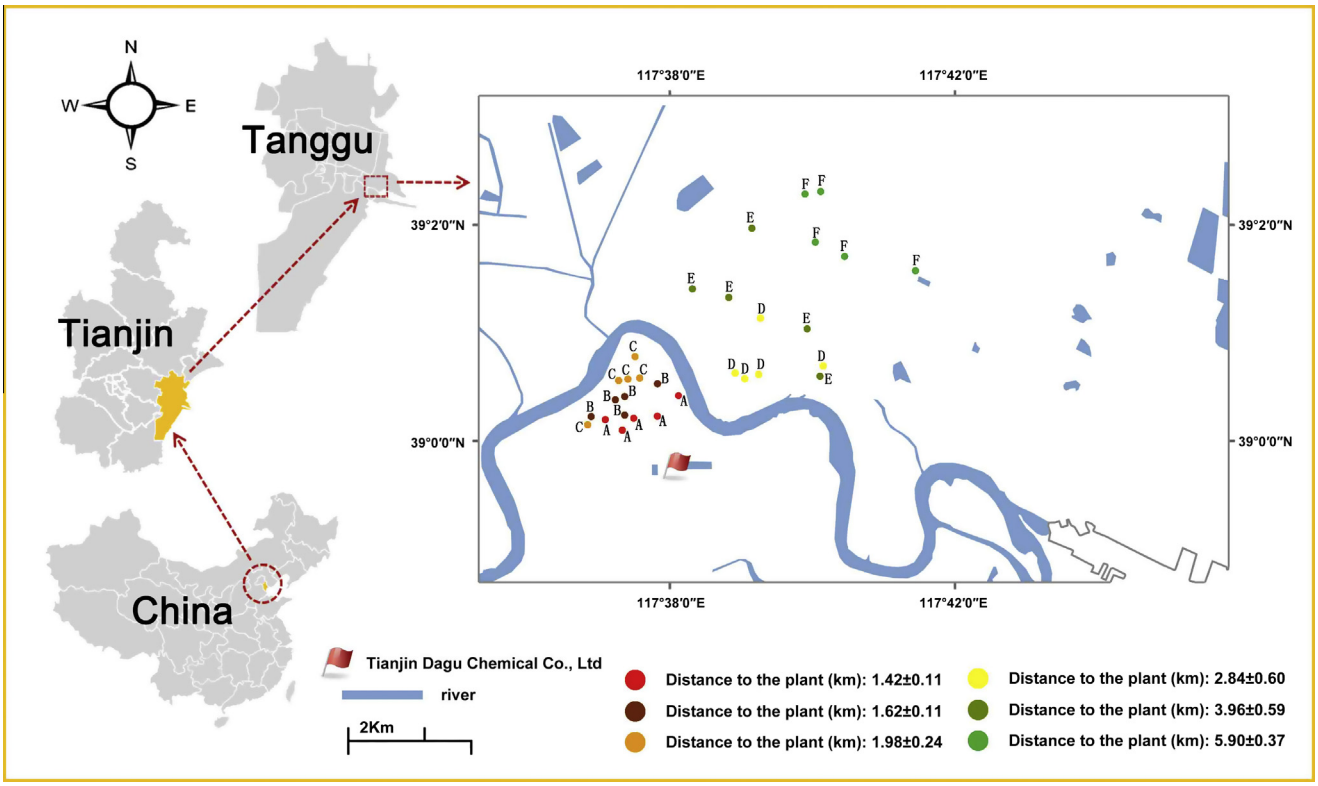

Fig. 1. Map showing the location of the sampling sites.